THE WEATHER AND CIRCULATION OF NOVEMBER 1953 [1]

A Month of Contrasting Regimes

JAY S. WINSTON

Extended Forecast Section, U. S. Weather Bureau, Washington, D. C.

TWO CONTRASTING CIRCULATION TYPES

The large-scale circulation in mid-troposphere changed markedly over much of the Northern Hemisphere between the first and second halves of November 1953. The differing circulation regimes which prevailed in the two halves of the month are illustrated by the 15-day mean 700-mb. charts in figure 1. The chart for November 1–15 (fig. 1A) shows a pattern of fairly rapid zonal flow with approximately sinusoidal waves of relatively small amplitude from the east coast of Asia eastward to the Atlantic, while somewhat lower index conditions prevailed over much of Europe and Asia. The wave length at middle latitudes was fairly uniform from the western Pacific trough eastward to the trough along the east coast of the United States. However, the Atlantic region was dominated by a deep trough south of Greenland longitudinally superimposed on the subtropical ridge in mid-Atlantic. This pattern was associated with well-marked confluence of cold air currents moving southeastward out of northern Canada and warm air currents moving northeastward from the western Atlantic. The very fast flow across the northeast Atlantic and northern Europe and the long half wave length at higher latitudes between the Atlantic trough and the Eurasian ridge are characteristic downstream features of such large-scale confluence zones (e. g. [1]).

By the second half of November radical readjustments in the wave pattern had taken place as the western Pacific trough strengthened and moved farther eastward off the Asiatic coast (fig. 1B). The circulation over the Pacific now became one vast cyclonic whirl of westerly winds as a single Pacific low cell deepened over the Aleutians. The rapid deepening of the Asiatic coastal trough at this season of the year is a normal feature of the circulation (see [2] pp. 28–29) associated with radiational cooling of the huge Asiatic continent in fall and strengthening of the frontogenetical and cyclogenetical field along the Asiatic coast. However, several outbreaks of abnormally cold Siberian air this November were apparently instrumental in creating the intense cyclonic circulation shown

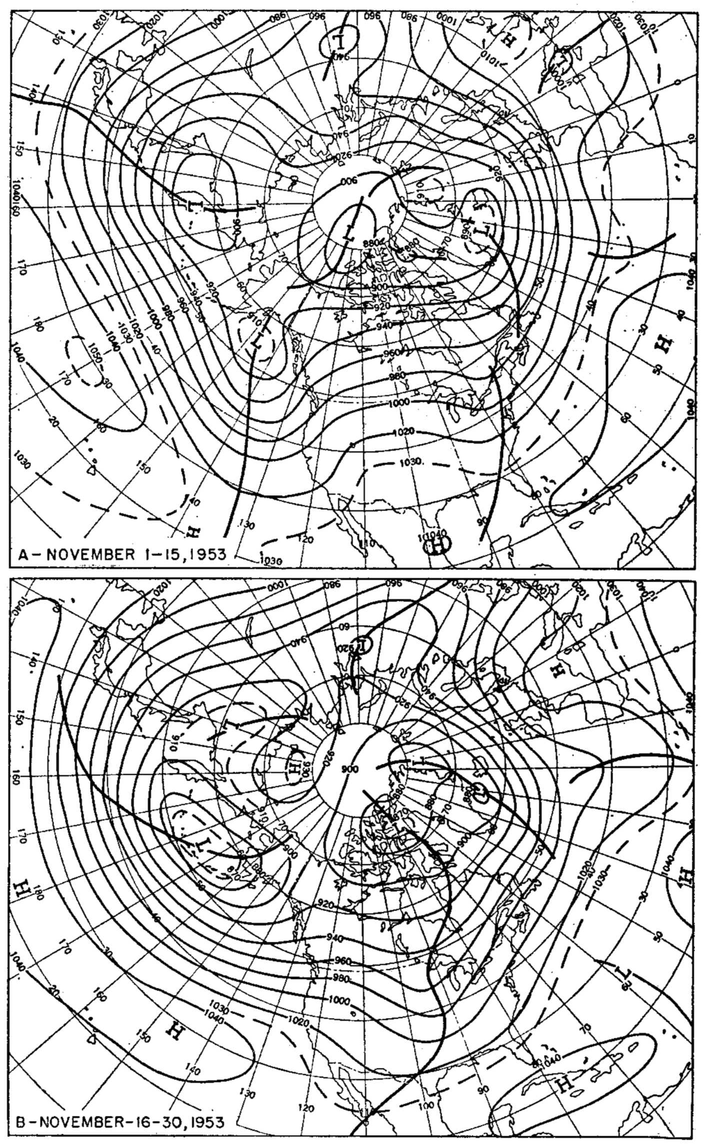

FIGURE 1.—Fifteen-day mean 700-mb. height contours (labeled in tens of feet) for (A) November 1-15 and (B) November 16-30, 1953, showing two contrasting circulation regimes. Note especially the change during the month from two troughs to a single deep trough over the Pacific and the development of a trough over central North America in the second half of the month.

[1] See Charts I-XV following p. 378 for analyzed climatological data for the month.

in figure 1B. This major deepening over the west central Pacific was accompanied by filling of the eastern Pacific trough and development of a weak ridge along the west coast of North America and a trough over central sections of North America. Note the considerable asymmetry of the wave between the western Pacific and central North America, i. e., the very short half wave length on the east side of the ridge over western North America as compared with the very long half wave length on the west side. This asymmetry was probably a result of a combination of at least two effects. One was the generation of cyclonic vorticity by deepening storms as they approached the Aleutians after developing in the strong frontal zone just off the Asiatic coast. This would forestall ridge development to a point farther downstream than would be expected by conservation of absolute vorticity. The effect of the Rockies on a strong westerly current was most likely responsible for the short half wave length east of the ridge. Klein [3] has demonstrated that such short half wave lengths are to be expected when the mid-latitude westerlies are strong across the ridge over western North America.

Development of a trough over central North America brought about a lengthening of the wave length and the termination of confluence over the Atlantic. As a result the westerlies over the Atlantic weakened and a trough developed at middle and lower latitudes in the eastern part of the ocean. Additional marked circulation changes over Europe and Asia accompanied the transitions in the Atlantic and farther upstream. Briefly, the major changes were (1) filling of the central Mediterranean trough, (2) development of a meridional ridge over western Europe which had apparently retrograded from Eurasia, (3) retrogression and development to higher latitudes of a trough over Eurasia, and (4) strengthening of westerlies over Siberia.

Thus it is evident that a virtual hemisphere-wide adjustment in circulation took place between the first and second halves of this November. Although such changes have been observed to take place in almost any month of the year, recent data of Namias [4] indicate that the period October to November is one of the more likely times of the year for the occurrence of marked breaks in circulation. It is worthy of note that Namias' data were for North America and vicinity only, but one might infer that more remote portions of the hemispheric circulation would also undergo reversals. Indeed circulation changes in recent late autumns (e. g., 1951 [5] and 1952 [6]) as well as this year have involved the greater part of the hemispheric wave pattern.

EFFECTS ON STORMINESS AND PRECIPITATION OVER THE UNITED STATES

This month's contrasting circulation regimes had a pronounced influence on cyclone tracks and precipitation during the two halves of November. These effects are illustrated by figures 2 and 3. In figure 2 are shown the tracks of centers of cyclones at sea level over the United States and vicinity. These tracks were copied directly from Chart X, but separation according to the two halves of November gives a clear picture of the great differences in cyclonic activity. Note in figure 2A the marked concentration of cyclone paths in southern Canada and the virtual absence of cyclones over most of the United States. The only cyclone in the first half of the month which had a major effect within the country was the severe East Coast storm which originated in the Gulf of Mexico on the 4th, traveled up the Atlantic coast in a cyclonically curved arc, and then moved inland across New York State and Lake Huron. This storm produced record early season snowfall at many middle Atlantic stations, heavy rains along the immediate coast and in much of New England, and severe gales and high tides along the coast from southern New England to New Jersey [7]. This cyclone was associated with the mean trough located along the east coast in the first half of November (fig. 1A). Meanwhile the absence of cyclones throughout the remainder of the United States was attributable to prevailing anticyclonic circulation over middle sections of the country.

Figure 2B portrays the increase in storminess over the United States associated with the well-developed trough over central North America in the second half of November (fig. 1B). No well-defined prevailing track is discernible, but the major storms most characteristic of the new circulation regime were those which originated in Nevada on the 17th and 20th and brought widespread precipitation of fairly sizeable amounts to much of the country.

Comparison of figures 3A and 3B shows the trend toward more precipitation over the United States accompanying the changing circulation pattern and increasing storminess after the middle of November. Note in figure 3A the large areas (perhaps 75 percent of the United States) where precipitation totaled less than 50 percent of normal. Especially remarkable was the large region in the Midwest where no measurable precipitation fell during the entire 15 days. This regime of predominantly subnormal precipitation over the United States is characteristic of periods when the main westerly belt and cyclone track are north of the United States, anticyclonic conditions prevail over the western and central portions of the country, and troughs are located near each coast. Heavier-than-normal precipitation was mainly confined to areas on the Atlantic and Pacific coasts on the east side of the mean troughs in figure 1A. Other areas of heavier-than-normal precipitation, such as those in east Texas, New Mexico, Colorado, and central portions of the Plains, do not appear to fit in with the mean flow pattern or with the lack of cyclones in those areas. This precipitation was related to upslope easterly wind components and to smaller-scale upper trough phenomena

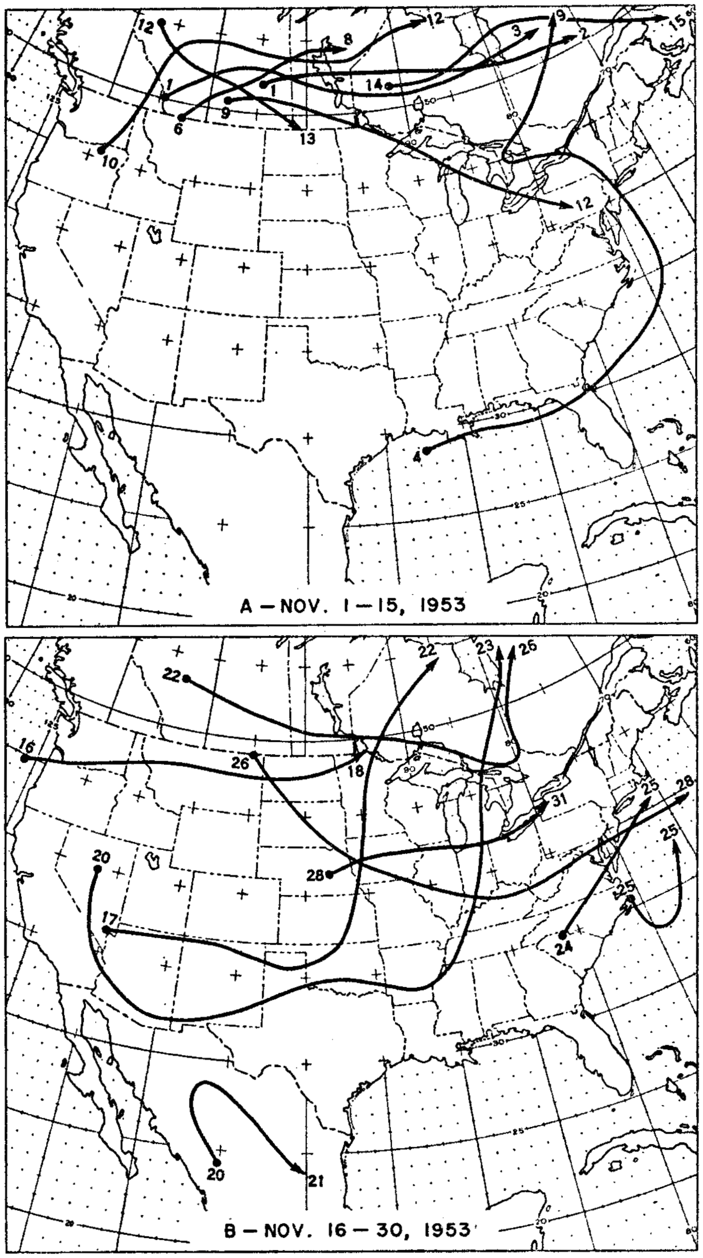

FIGURE 2.—Tracks of centers of cyclones at sea level during (A) November 1–15 and (B) November 16–30, 1953, showing the lack of cyclonic activity over the United States during the first half of the month and the increasing cyclonic activity over the country in the second half of the month as a mean trough developed over central United States.

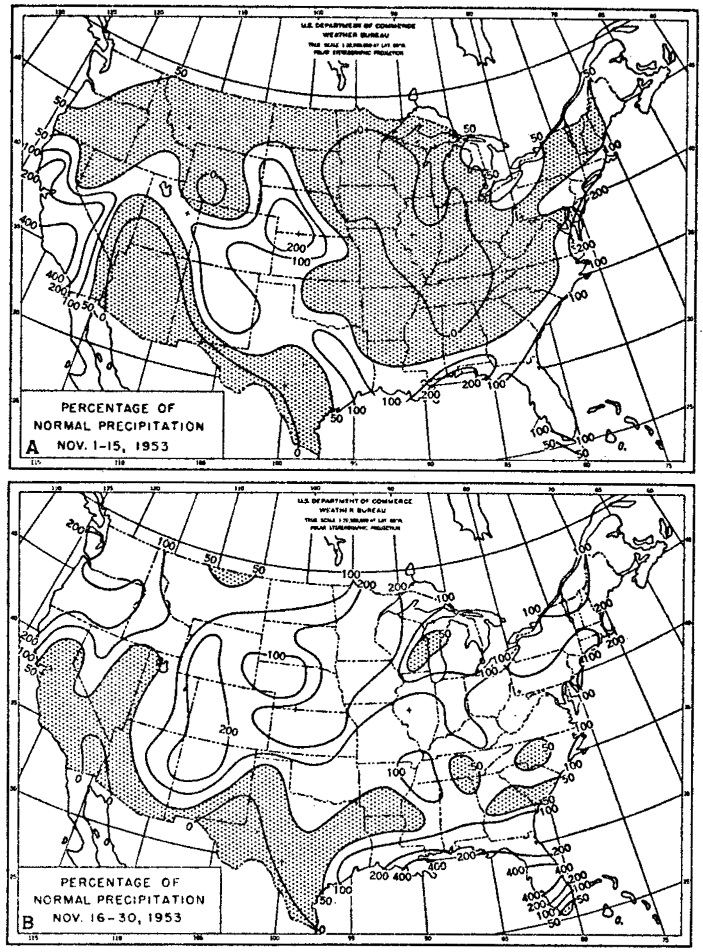

FIGURE 3.—Percentage of normal precipitation for (A) November 1–15 and (B) November 16–30, 1953, portraying general increase in precipitation from very dry conditions in many areas in the first half of the month to more normal precipitation amounts in the second half. These changes are related to basic changes in circulation and storminess shown in figures 1 and 2.

which lasted only a few days and were smoothed out of the large-scale flow pattern.

In figure 3B the areas totaling less than 50 percent of normal occupy only a small portion of the country. In fact, in almost half of the nation precipitation exceeded normal amounts. This was related to intensifying trough conditions and increasing storminess over the central United States as already mentioned. It is somewhat surprising, though, that much of the eastern half of the United States had subnormal precipitation amounts even though this region was located under southwesterly flow in advance of the mean upper-level trough. It is believed that this was due to an insufficient supply of moisture from the Gulf of Mexico over this region. Indicative of this were the absence of a well-developed Bermuda High cell and the existence of flat westerly flow along the Gulf coast which tended to transport Gulf air masses almost directly eastward across the extreme Southeast. As a result, much of the Gulf Coast States and Florida received rather substantial amounts of rainfall in this period while amounts farther north were considerably lighter. Nevertheless, the most important consideration in comparing figures 3A and 3B is that precipitation generally increased over large sections of the country, some of which were still feeling the effects during early November of the long-period drought of summer and fall (See e. g., [8].).

One of the most interesting changes in precipitation regimes occurred over the Far West where California received excessive precipitation in the first half of November while the Northwest had subnormal amounts. Figure 3B shows a virtually complete reversal during the second half of the month with less than 50 percent of normal over most of California and amounts in excess of normal over all of Washington and Oregon and most of Idaho. These differences were closely related to the differing

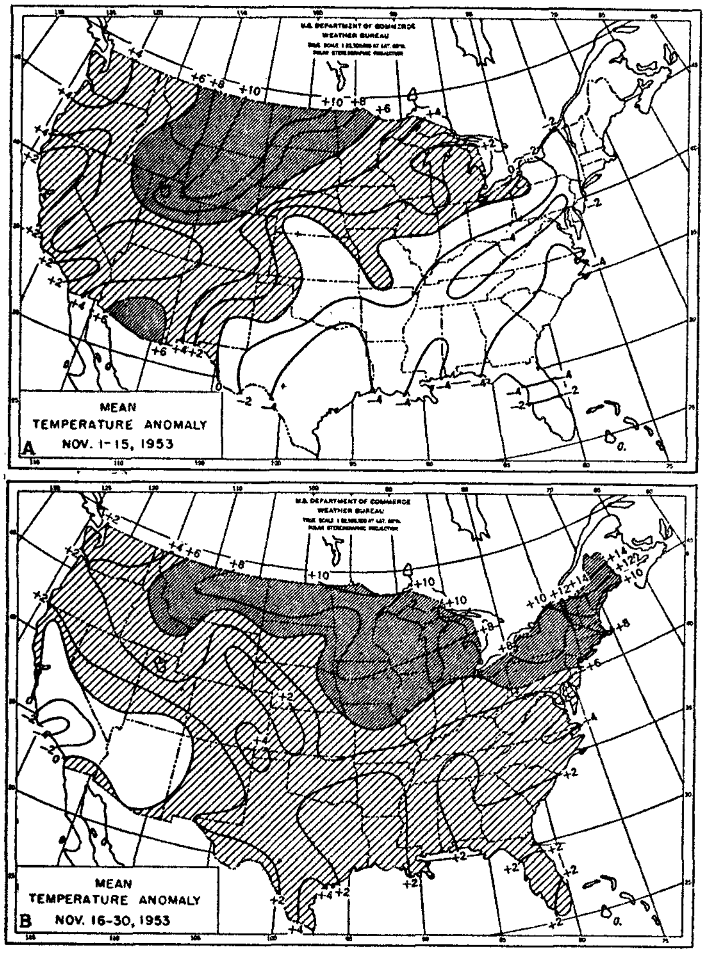

FIGURE 4.—Mean surface temperature anomaly in °F. for (A) November 1-15 and (B) November 16-30, 1953. Note general warming over East and South and some cooling over Far Southwest as circulation regime changed. Northern border sections from Lakes westward remained very warm throughout month owing to the prevalence of mild Pacific air masses brought eastward by zonal flow patterns shown in figure 1.

character of circulation over the West Coast States where precipitation is greatly influenced by orographic effects. Figure 1A portrays a basically meridional flow to the east of the deep trough in the eastern Pacific. This flow was perpendicular to the California coast, but made much less of an angle with the Washington-Oregon coastline. In addition, the greatest cyclonic curvature in the flow existed over California. In the second half of November (fig. 1B) strong zonal flow was dominant along the west coast with the strongest belt of westerlies striking Washington and Oregon. Characteristically these winds, which were perpendicular to the coast and the mountain ranges, brought copious precipitation to the Northwest. Meanwhile the mean flow in California was anticyclonic and parallel to the coast and the mountains, thereby allowing only considerably subnormal amounts of precipitation.

DIFFERING TEMPERATURE REGIMES

Mean temperatures for the two halves of November also showed some significant differences as a result of the changing circulation regimes. From November 1 to 15 below normal temperatures were experienced in almost half of the country from the Northeast southward to Florida and southwestward to the Southern Plains (fig. 4A). This cold weather was associated with the well-defined trough near the east coast and northerly components of flow over the eastern half of the nation. Weaker-than-normal westerly flow over the South Central States allowed for penetration and lingering of cold continental polar air which moved southward east of the Mississippi Valley. Across the north, where westerlies were stronger, warm Pacific air masses frequently spread eastward through the Northern Plains and into the Lakes Region following cold air outbreaks in the East. Furthermore, the Lakes Region and Upper Mississippi Valley were also kept warm by return flow of continental polar air which had been heated over the Southeast. Pacific air masses reaching the west coast in the first half of the month had trajectories which traversed unusually low latitudes in the eastern Pacific so that rather mild weather prevailed throughout the West. It was especially warm over the northern Rockies and Northern Plains as this southern Pacific air reached latitudes which normally experience considerably colder air masses in November both from the Canadian and northern Pacific source regions. Foehn warming on the leeward mountain slopes and anticyclonic circulation aloft undoubtedly enhanced the mildness of the air in much of this region.

The second half of November was warmer than normal over most sections of the United States (fig. 4B). The development of the trough over the central United States (fig. 1B) brought warm air to the entire eastern half of the country as southerly flow components set in ahead of the trough. Even though northwesterly flow developed over the western half of the United States, temperatures still remained generally above normal. This is attributable to the fast westerly flow crossing the west coast and the northern Rockies, which continued to bring mild Pacific air into the country and prevented major outbreaks of Canadian polar air masses from entering the circulation to the rear of the United States trough. Furthermore, the circulation pattern which existed over Canada throughout October [8], the first half of November (fig. 1A), and even the second half of November (fig. 1B) was one of fast zonal flow which prevented development of cold air over the Canadian source region. Mean temperatures in the layer 1000 to 700 mb. over central Canada (not shown) averaged as much as 5° to 6° C. above normal throughout October and November. Thus those outbreaks of Canadian air which did occur in the second half of November generally produced temperatures which were above normal in the northern border States and only slightly below normal even in the South Central States. Cool weather prevailed during this second half of November only in California, southern Nevada, and Arizona. Apparently the Pacific air masses had enough of a northerly origin to bring temperatures slightly below normal for these lower latitudes.

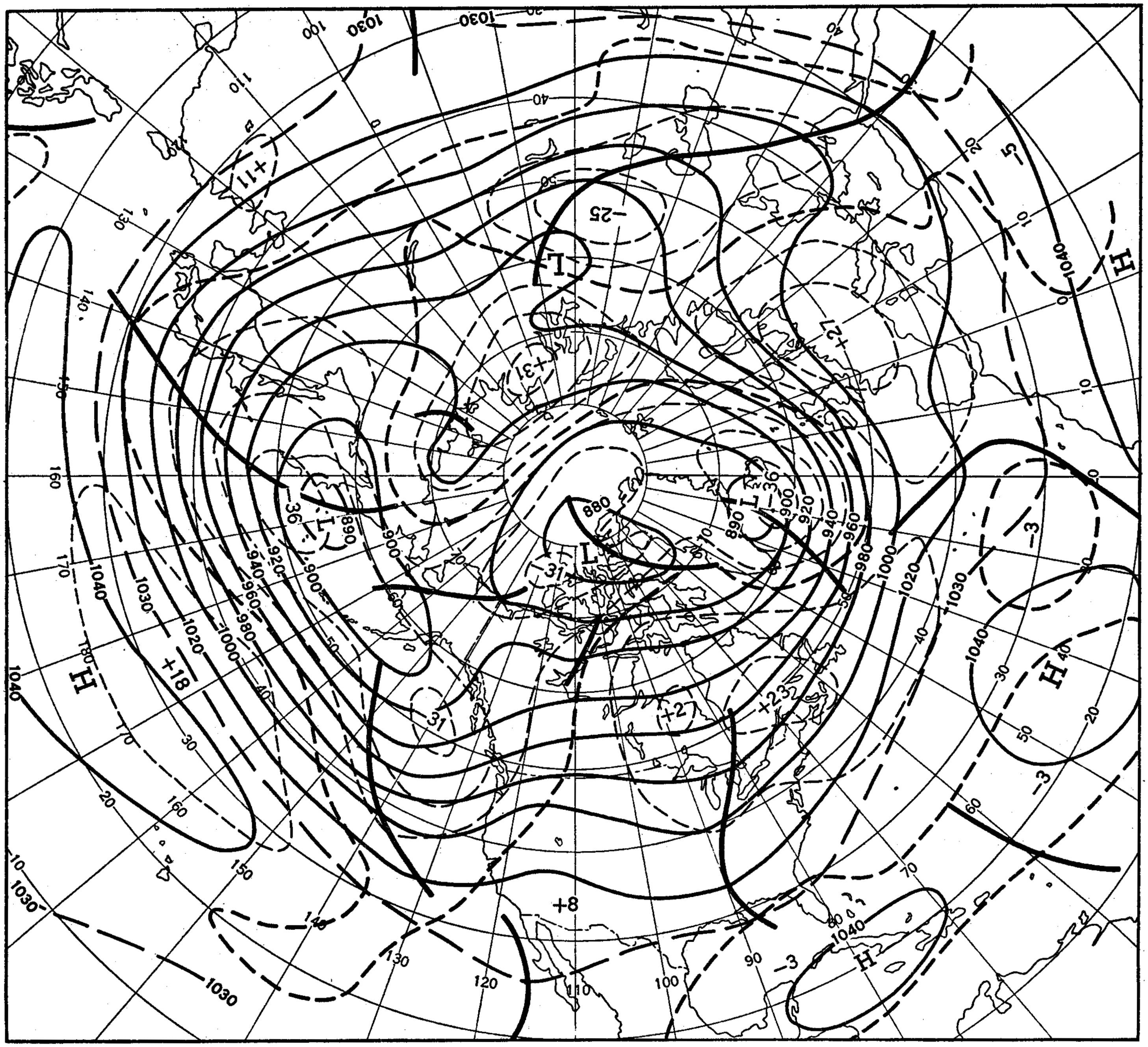

FIGURE 5.—Mean 700-mb. chart with height contours and departures from normal (both labeled in tens of feet) for October 31–November 29, 1953. This shows many of the individual features of figures 1A and 1B, so much so that four troughs exist between eastern Asia and the eastern Atlantic with rather short wave lengths for strong zonal flow.

MONTHLY MEAN CIRCULATION

In spite of the large contrasts in circulation regimes during November the monthly mean 700-mb. chart exhibits a fairly well-defined circulation pattern (fig. 5). As might be expected, it embodies characteristic features of both 15-day charts (fig. 1), so that a large wave number exists over the hemisphere with four major troughs from the east coast of Asia eastward to the eastern Atlantic. However, it was shown earlier in the discussion of figure 1 that the eastern Pacific trough existed only in the first half of the month while the eastern Atlantic trough at middle and low latitudes only developed in the second half of the month. Thus in such transition states as these the monthly mean chart may exhibit some abnormally short wave lengths.

One of the more interesting features of figure 5 is the large area of above normal heights which prevailed over much of Canada, the United States, and the western Atlantic. This represented a good deal of persistence from October [7] and these departures only began to fall away over central North America during the second half of

November. Associated with this extensive positive anomaly, with centers over Hudson Bay and the Gulf of St. Lawrence, were a large area of positive mean sea level pressure anomaly over eastern Canada (Chart XI inset) and an abnormally high frequency of sea level anticyclones traversing central and eastern Canada (Chart IX).

REFERENCES

1. P. F. Clapp and J. S. Winston, "A Case Study of Confluence as Related to the Jet Stream," *Journal of Meteorology*, vol. 8, No. 4, August 1951, pp. 231–243.
2. U. S. Weather Bureau, "Normal Weather Charts for the Northern Hemisphere," *Technical Paper* No. 21, 1952, 73 pp.
3. W. H. Klein, "Some Empirical Characteristics of Long Waves on Monthly Mean Charts," *Monthly Weather Review*, vol. 80, No. 11, November 1952, pp. 203–219.
4. J. Namias, "The Annual Course of Month-to-Month Persistence in Climatic Anomalies," *Bulletin of the American Meteorological Society*, vol. 33, No. 7, September 1952, pp. 279–285.
5. W. H. Klein, "The Weather and Circulation of November 1951," *Monthly Weather Review*, vol. 79, No. 11, November 1951, pp. 208–211.
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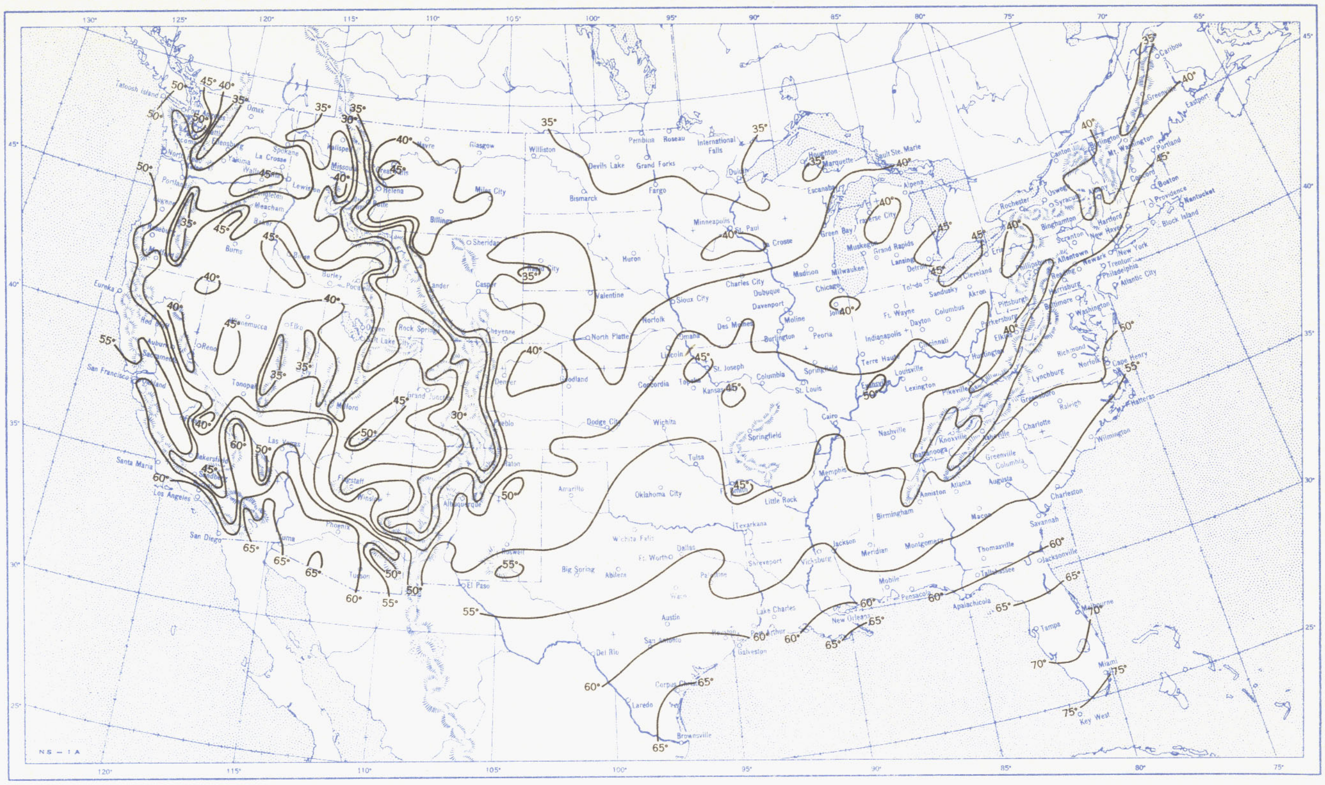
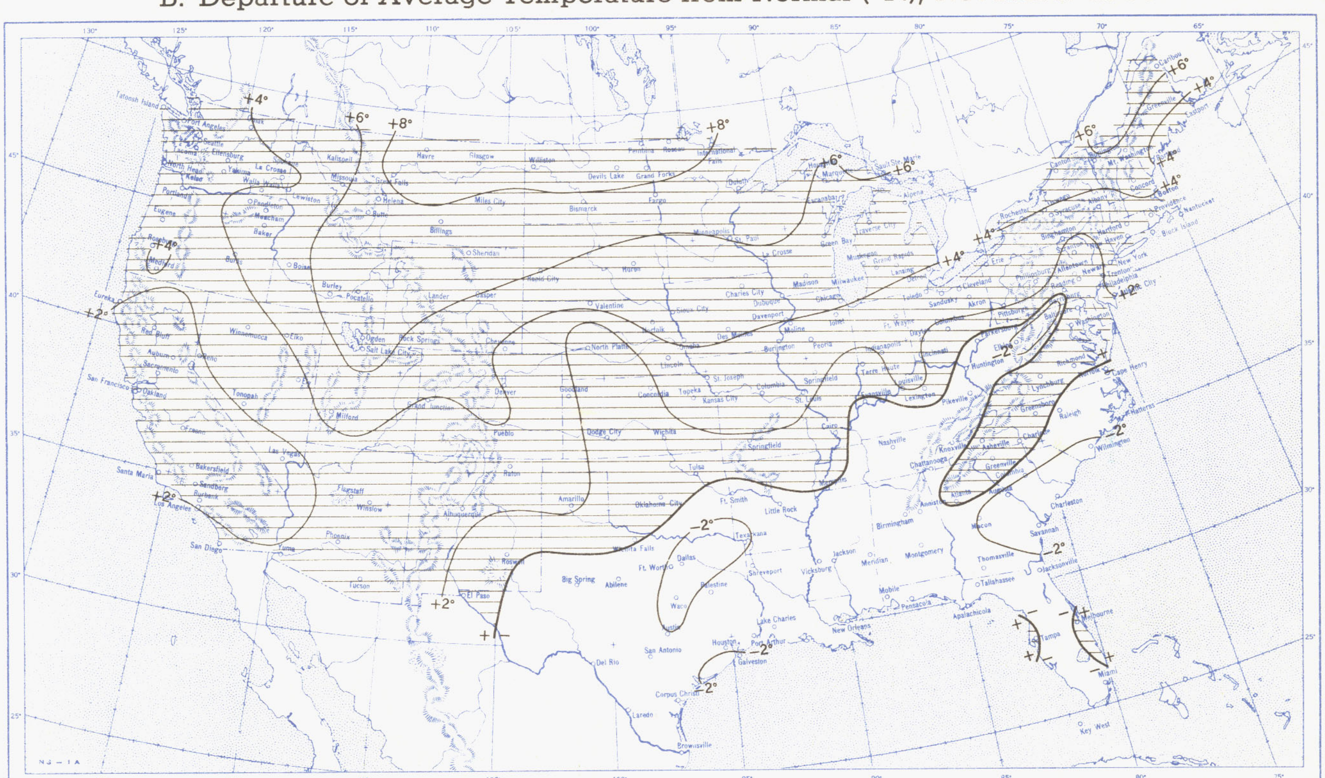
7. J. R. Fulks, "The Early November Snowstorm of 1953," *Weather-wise* (to be published in February 1954 issue).
8. H. F. Hawkins, Jr., "The Weather and Circulation of October 1953—The Beginning of Drought Alleviation," *Monthly Weather Review*, vol. 81, No. 10, October 1953, pp. 336–341.

Chart I. A. Average Temperature (°F.) at Surface, November 1953.

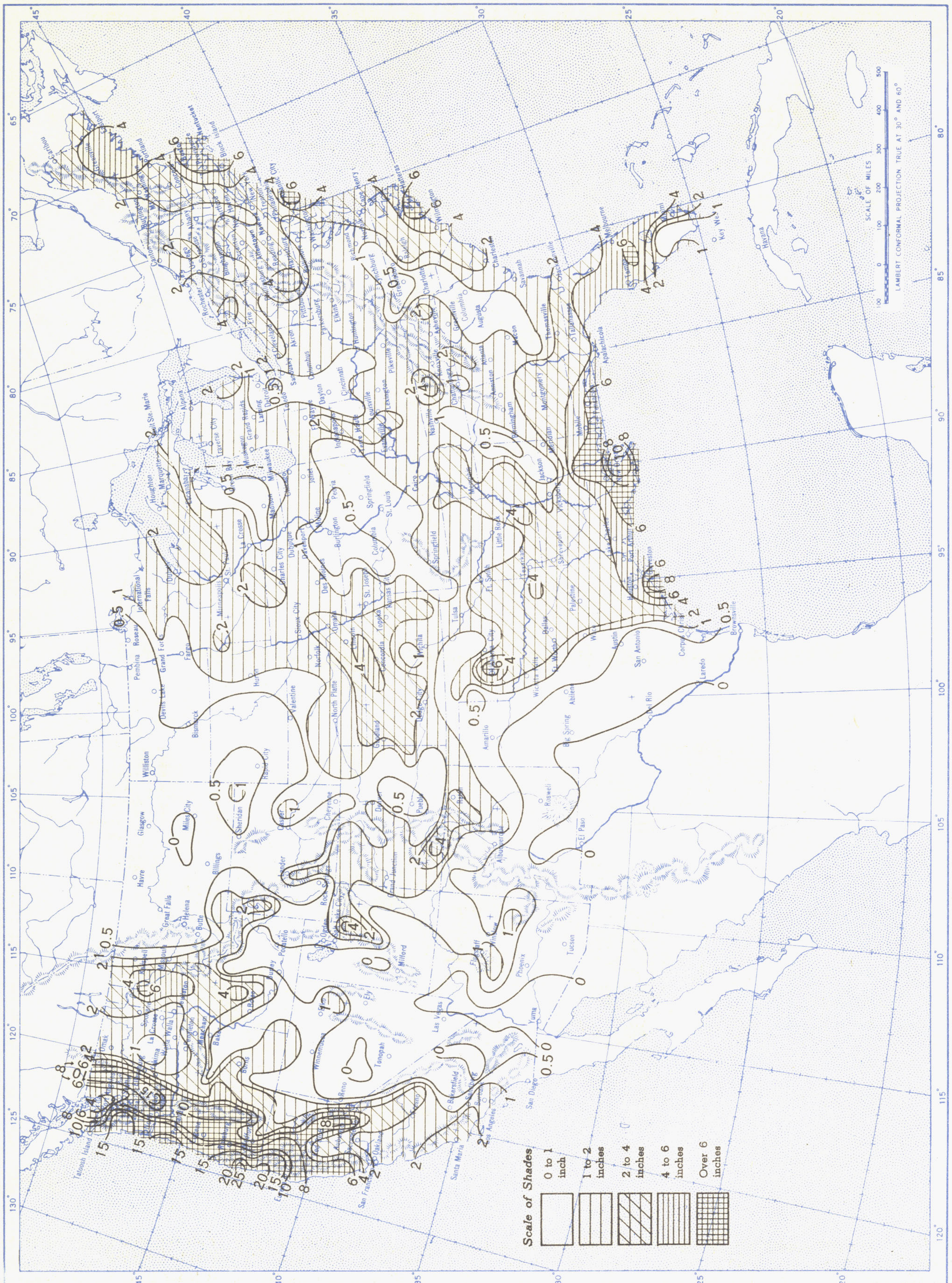


B. Departure of Average Temperature from Normal (°F.), November 1953.



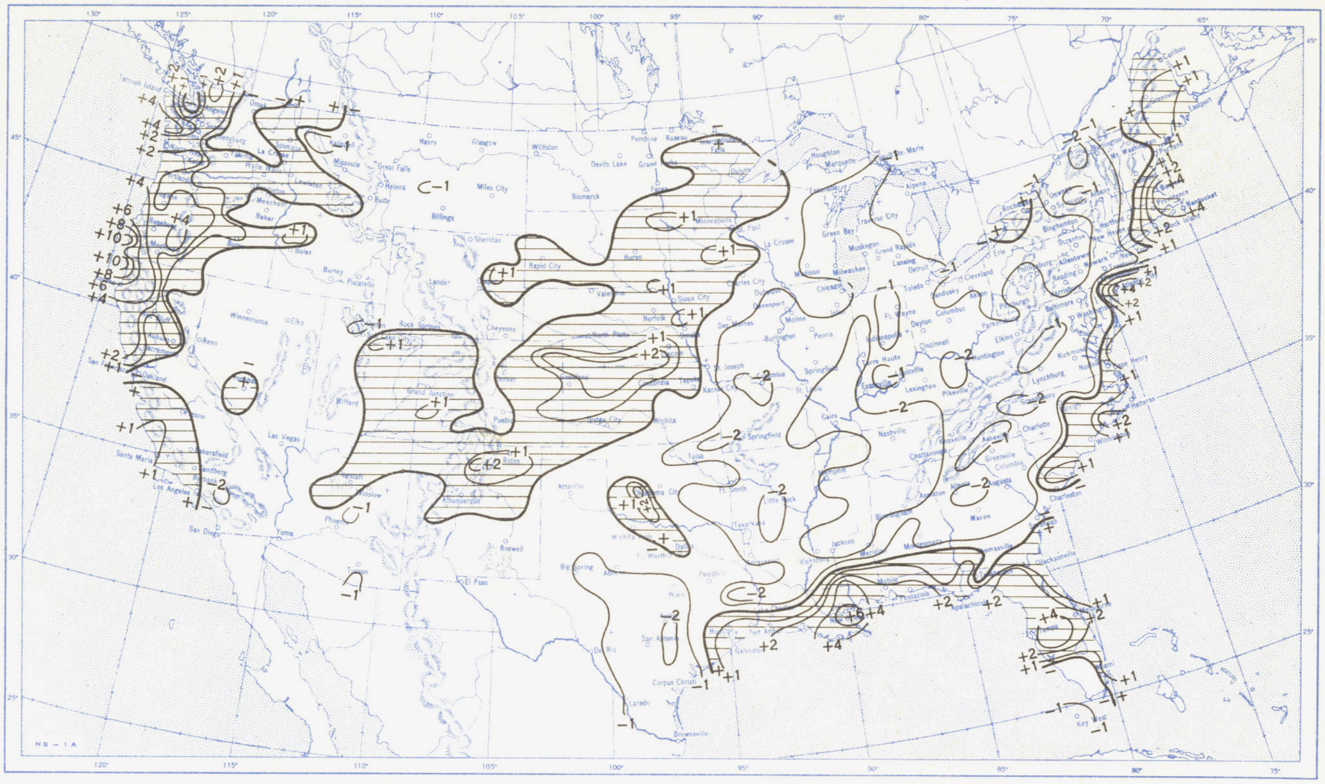
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), November 1953.

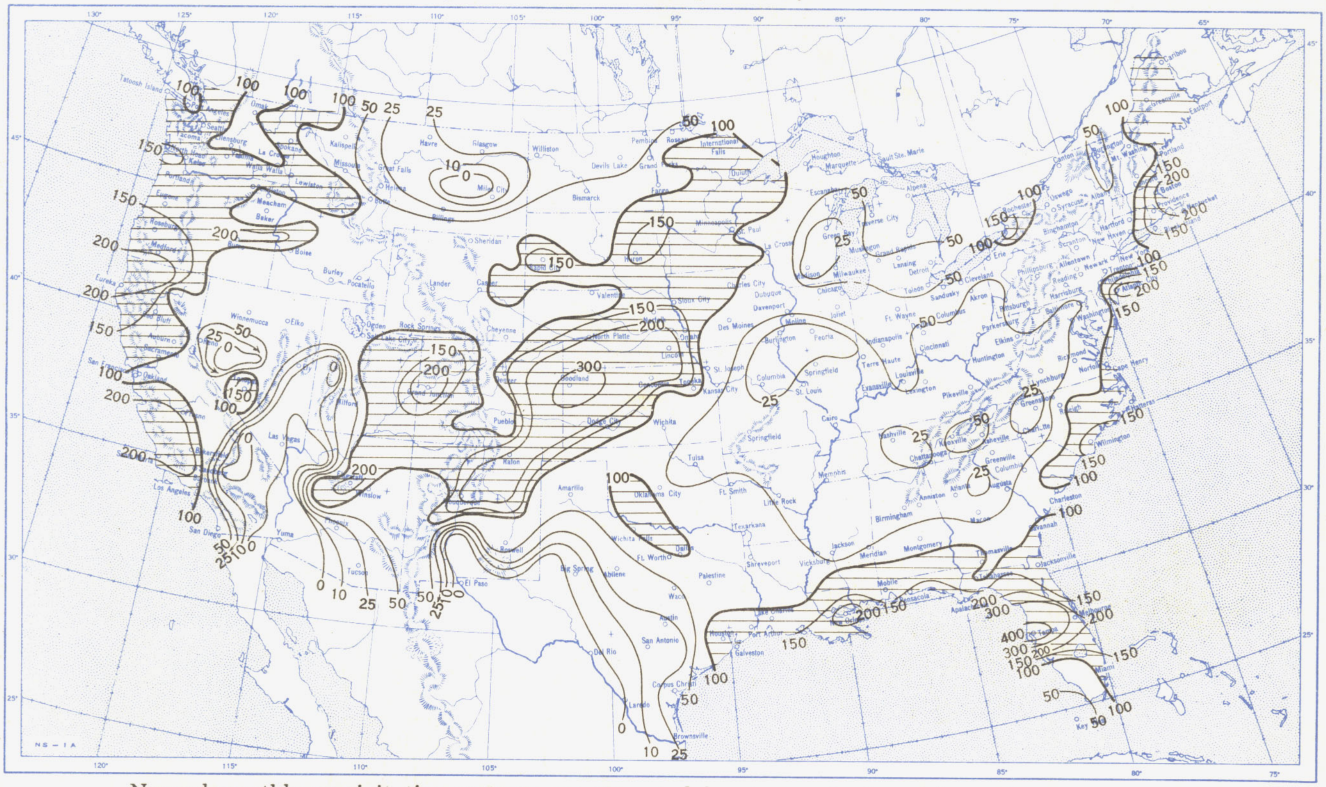


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), November 1953.



B. Percentage of Normal Precipitation, November 1953.

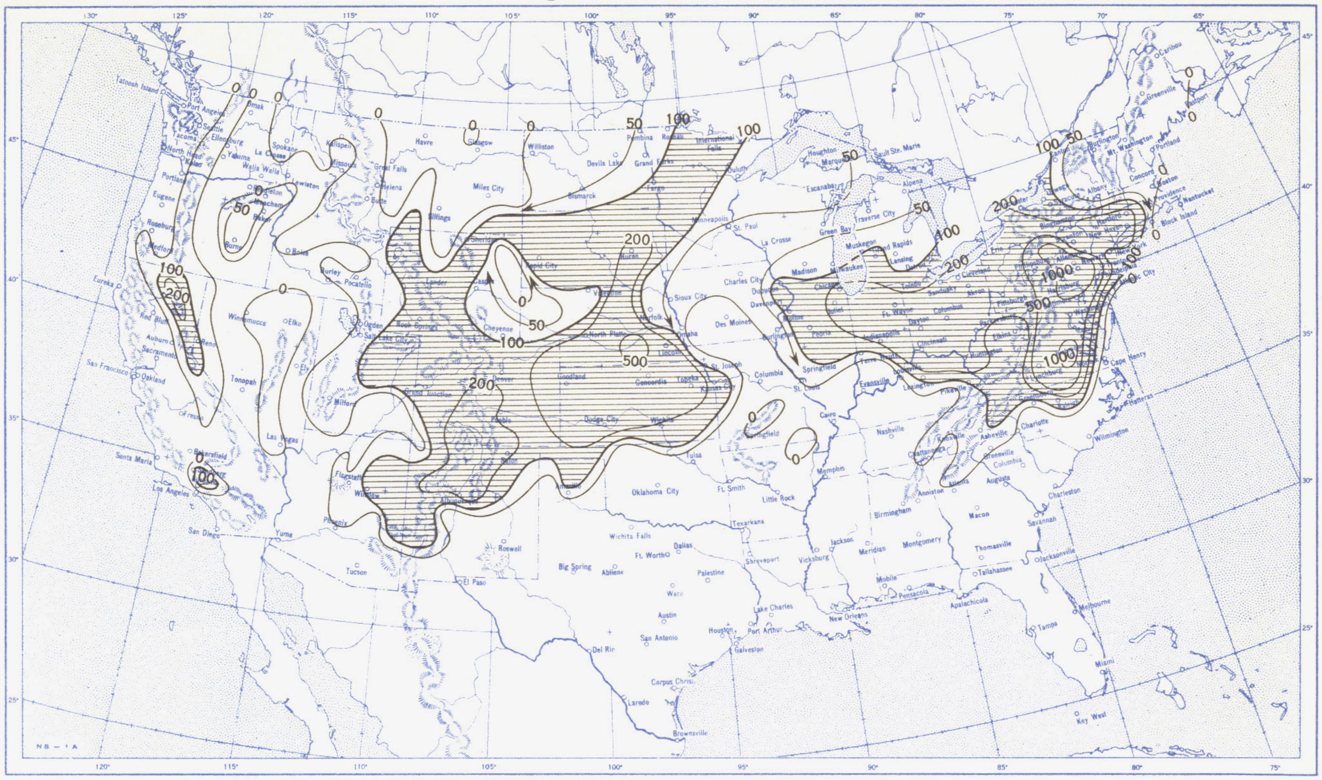


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart IV. Total Snowfall (Inches), November 1953.

This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

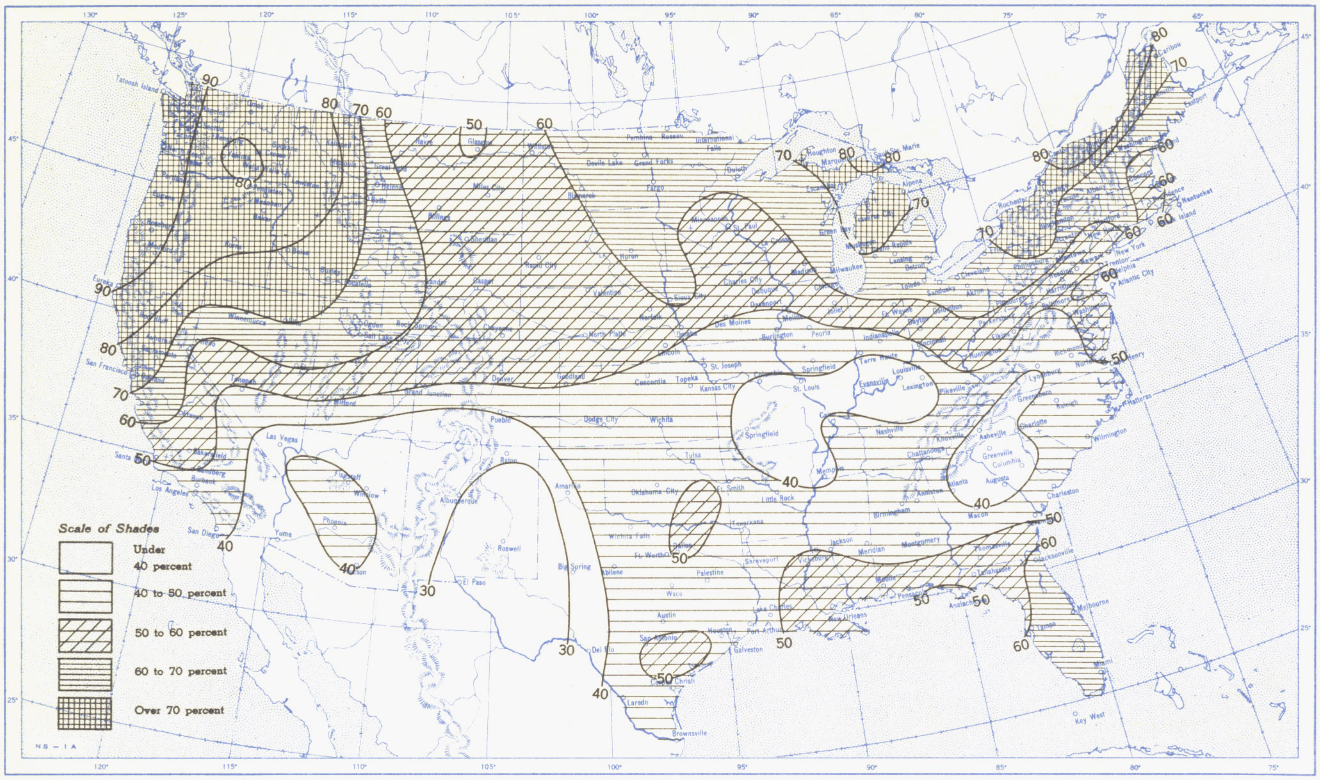
Chart V. A. Percentage of Normal Snowfall, November 1953.



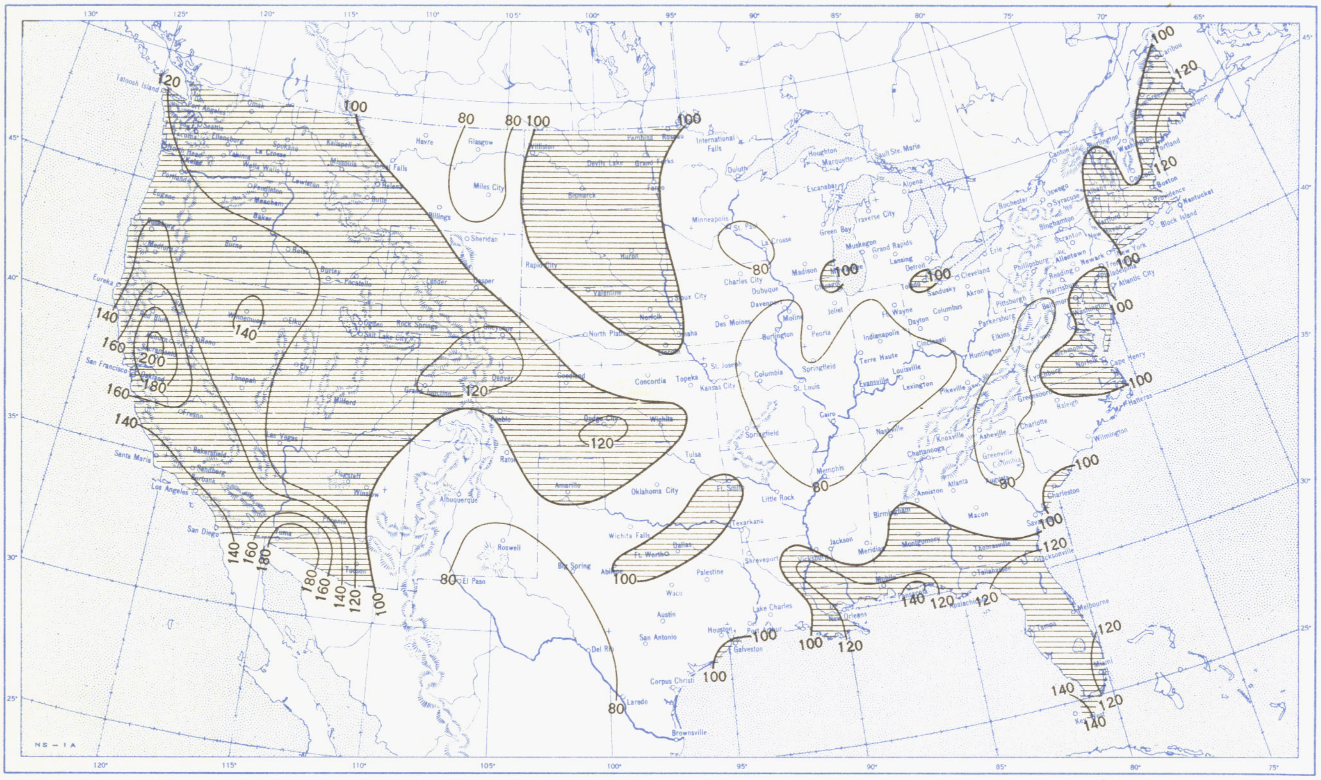
B. Depth of Snow on Ground (Inches)

A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record. B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, November 1953.

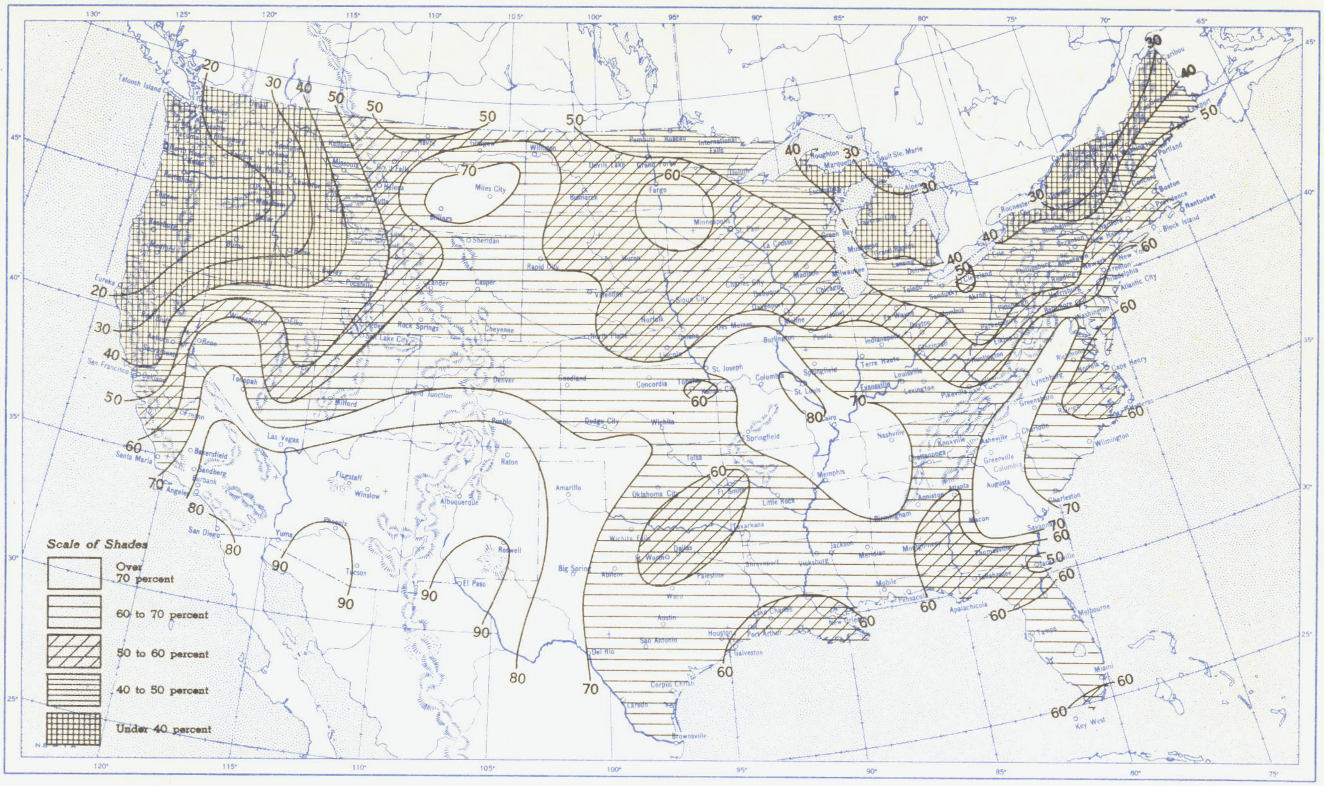


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, November 1953.

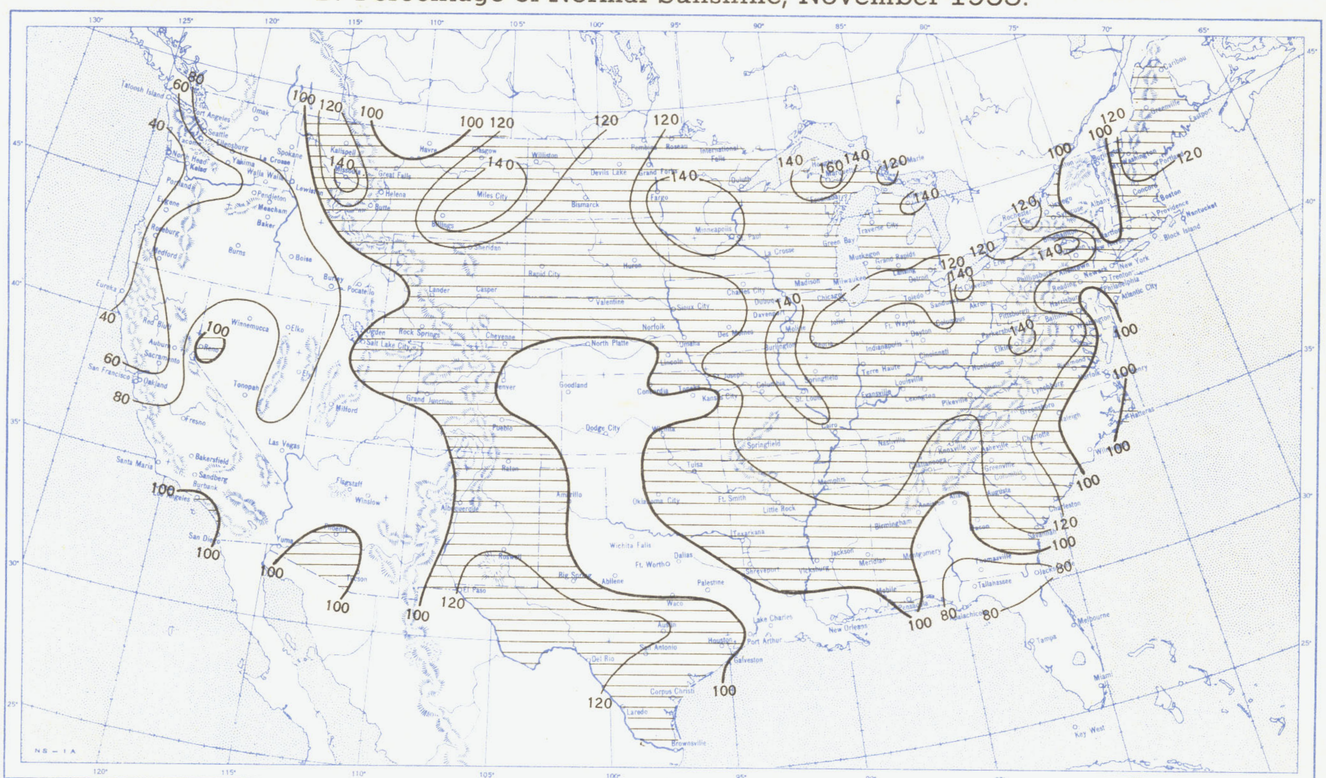


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, November 1953.



B. Percentage of Normal Sunshine, November 1953.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, November 1953. Inset: Percentage of Normal Average Daily Solar Radiation, November 1953.

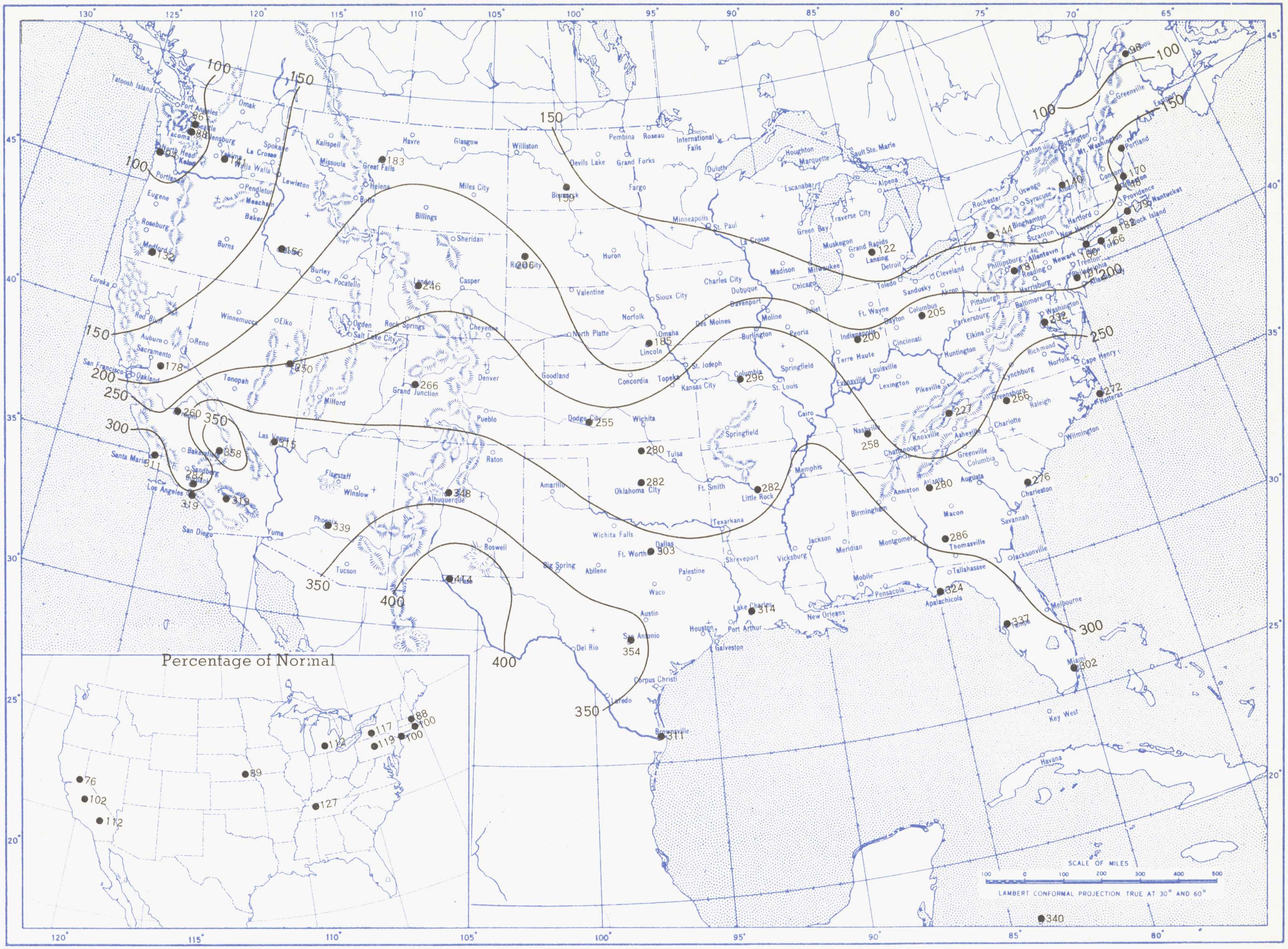
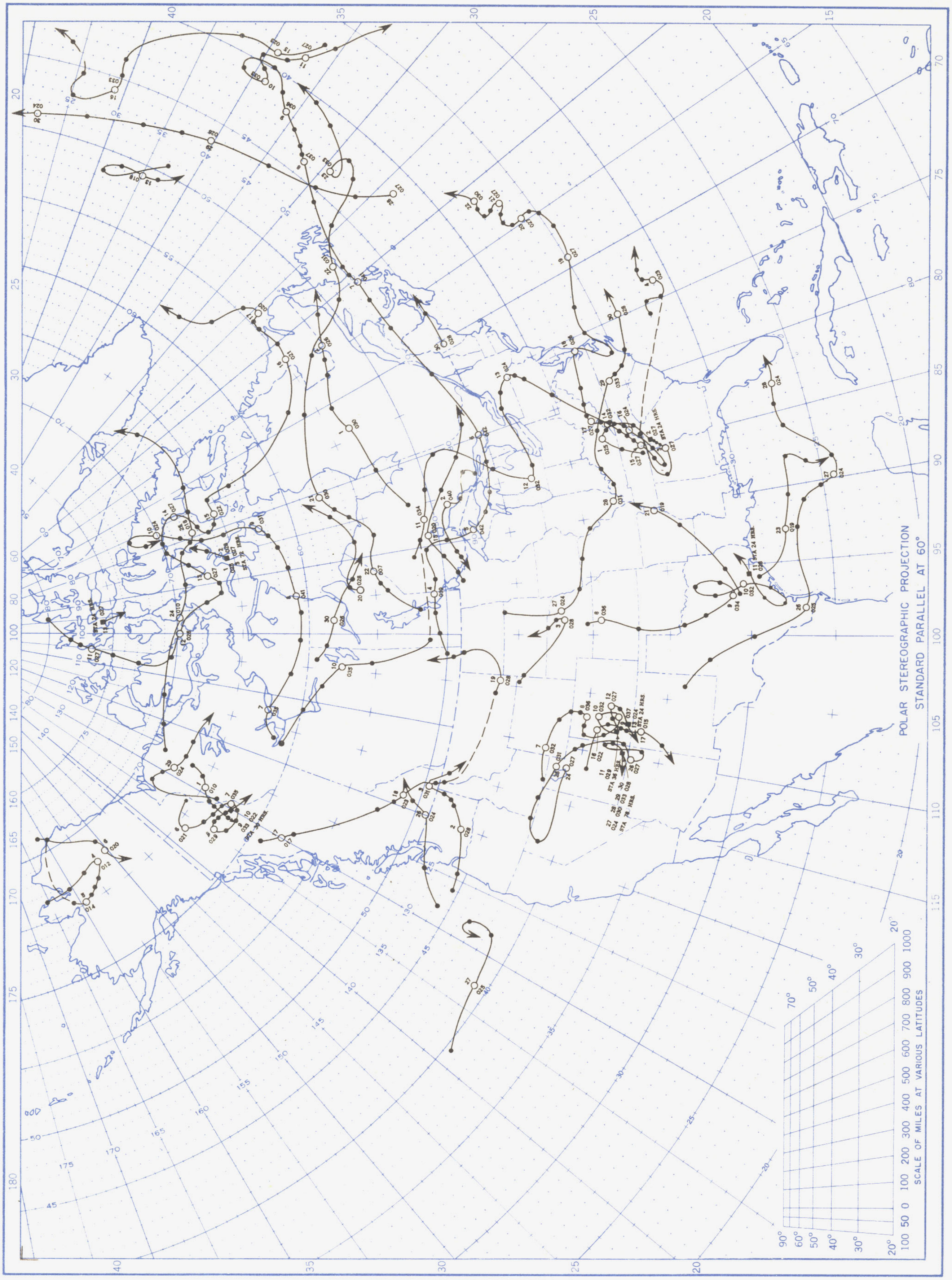


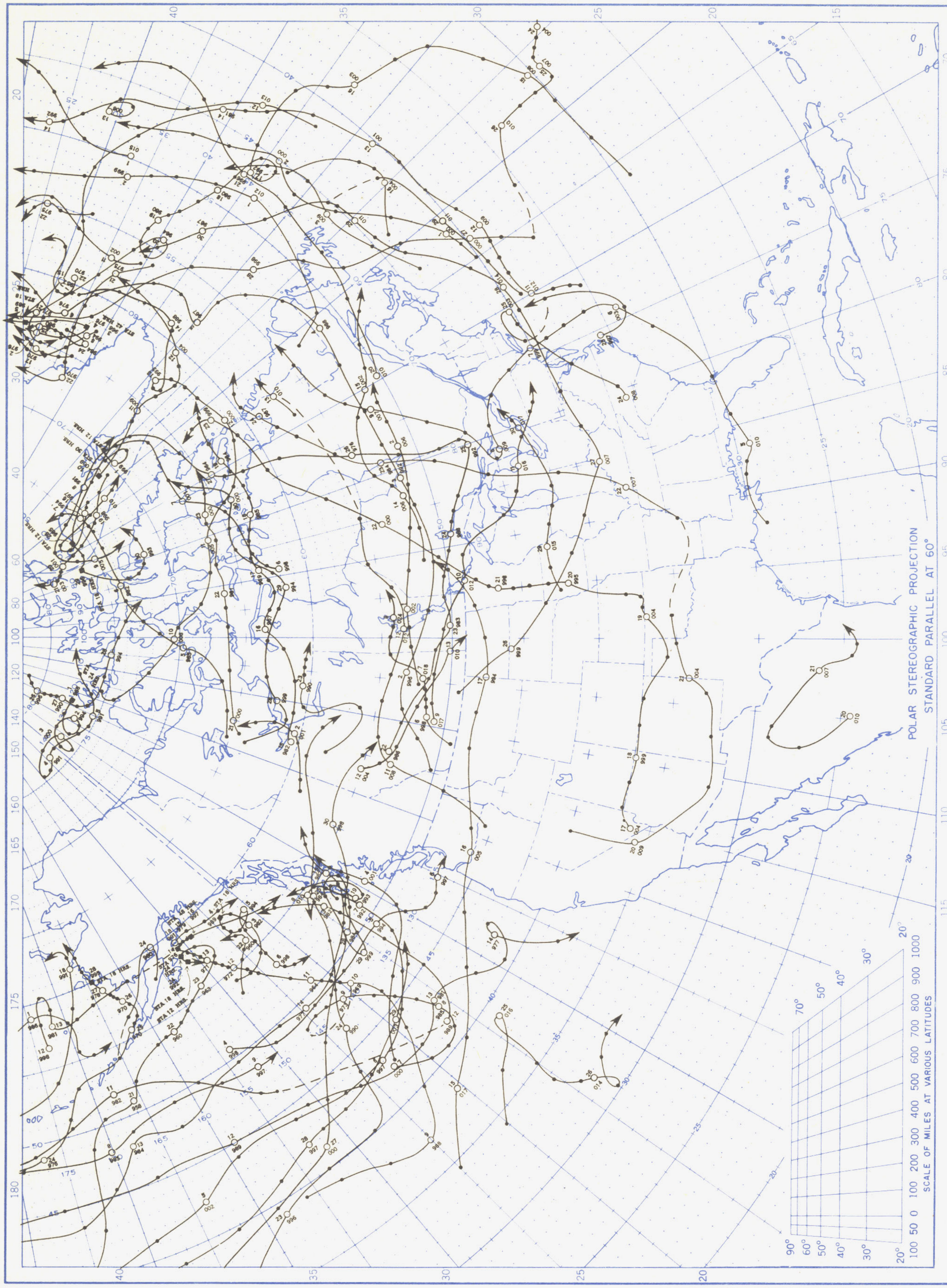
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, November 1953.



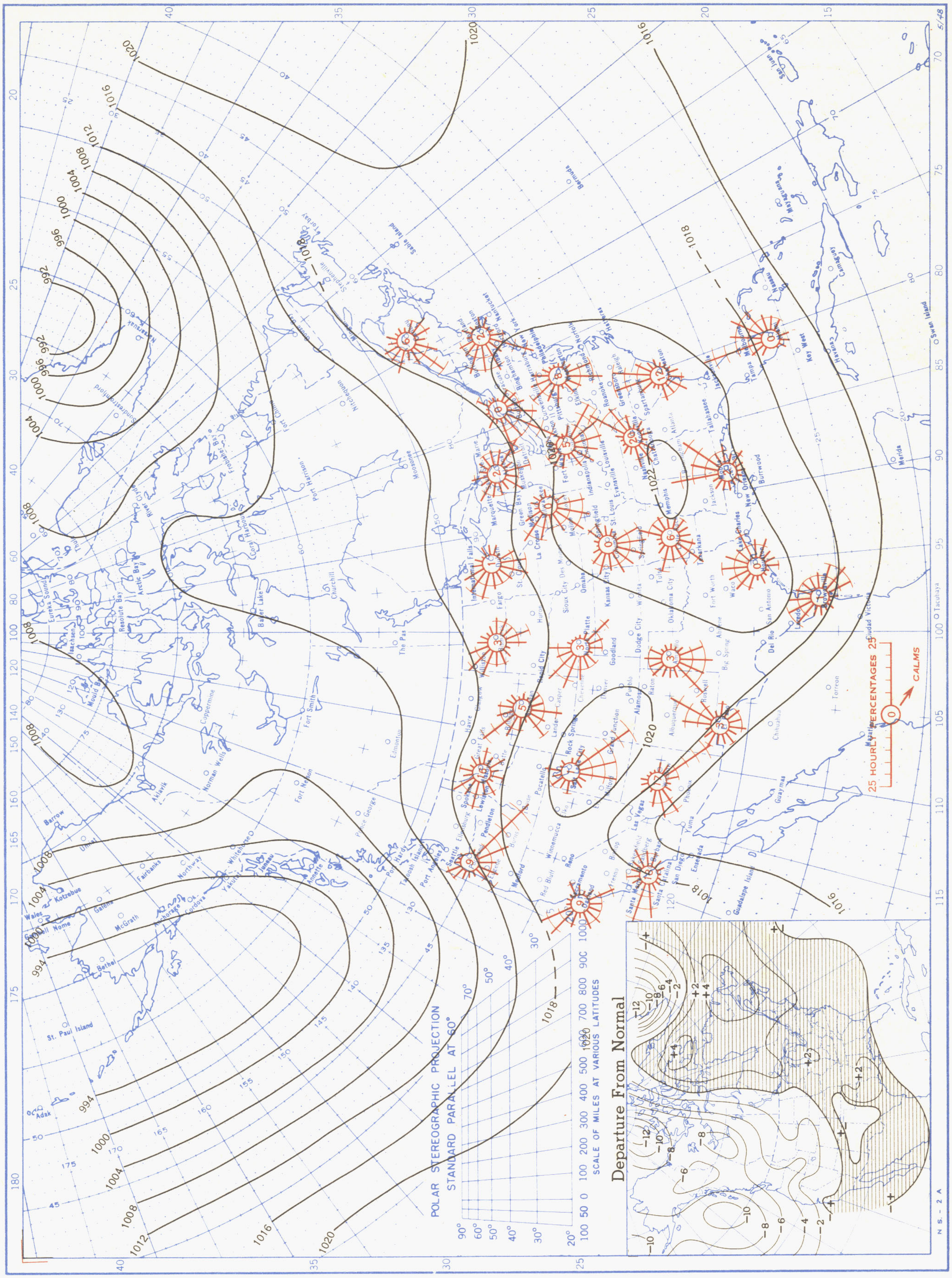
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, November 1953.



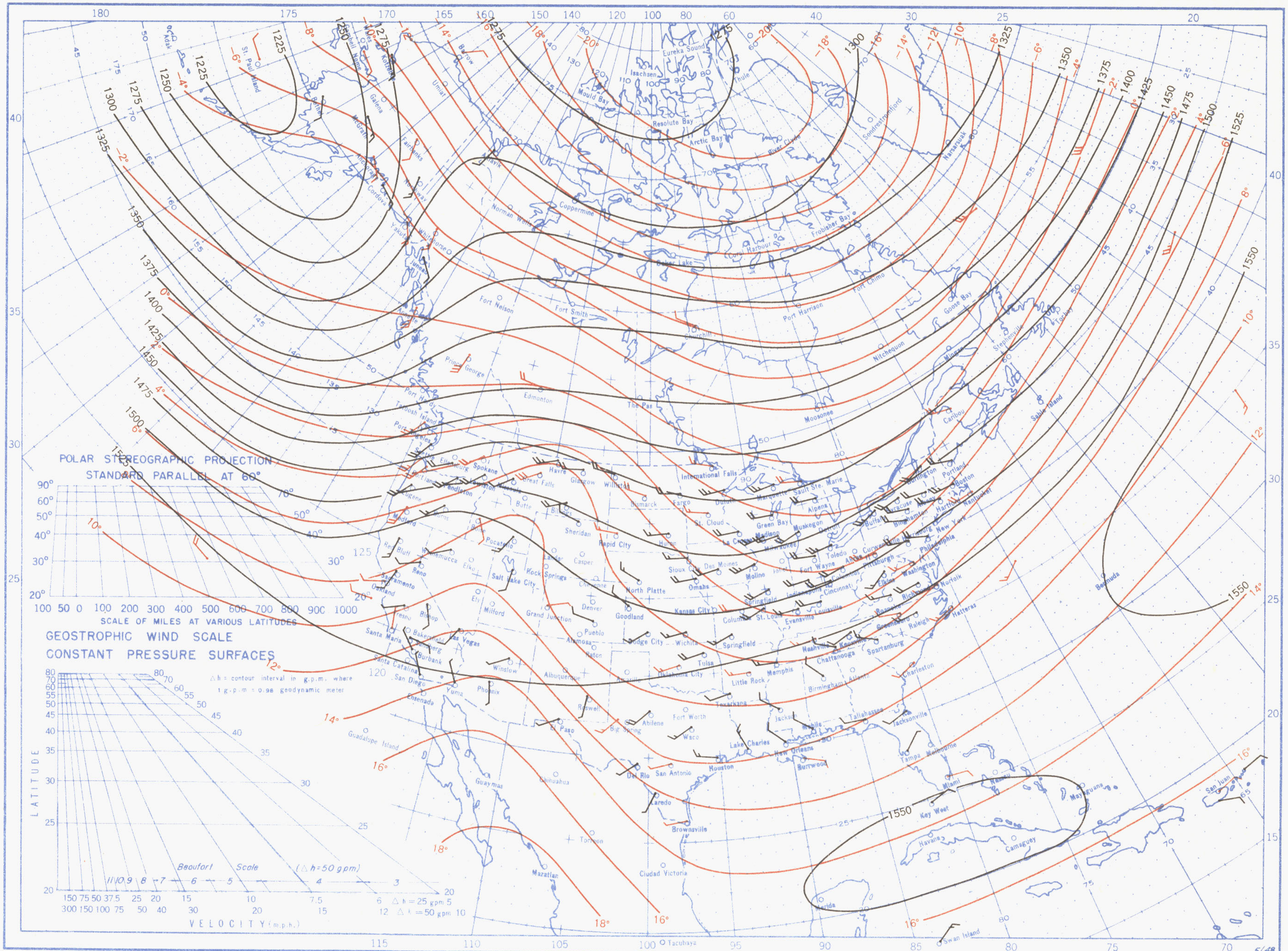
Circle indicates position of center at 7:30 a.m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, November 1953. Inset: Departure of Average Pressure (mb.) from Normal, November 1953.



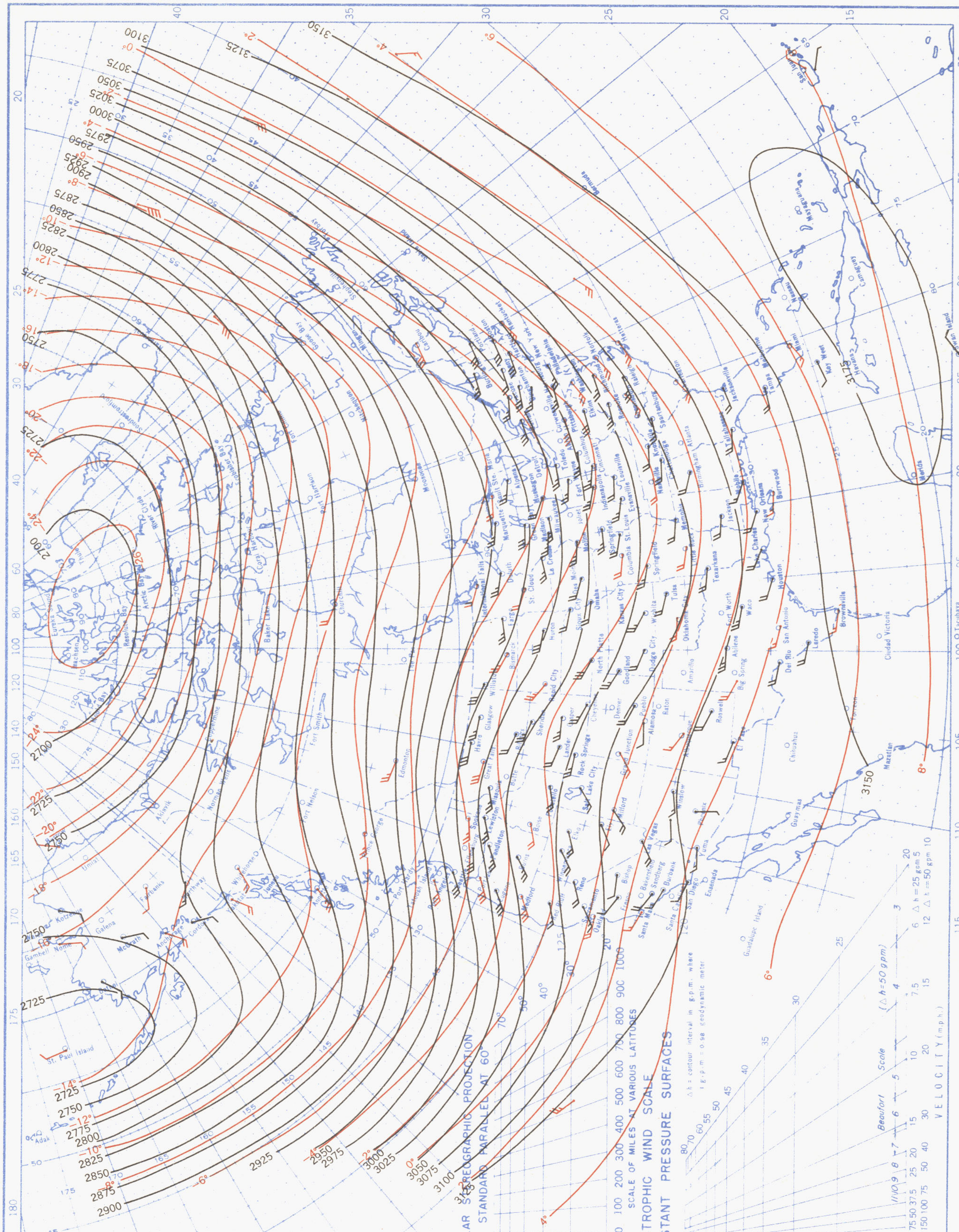
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), November 1953.



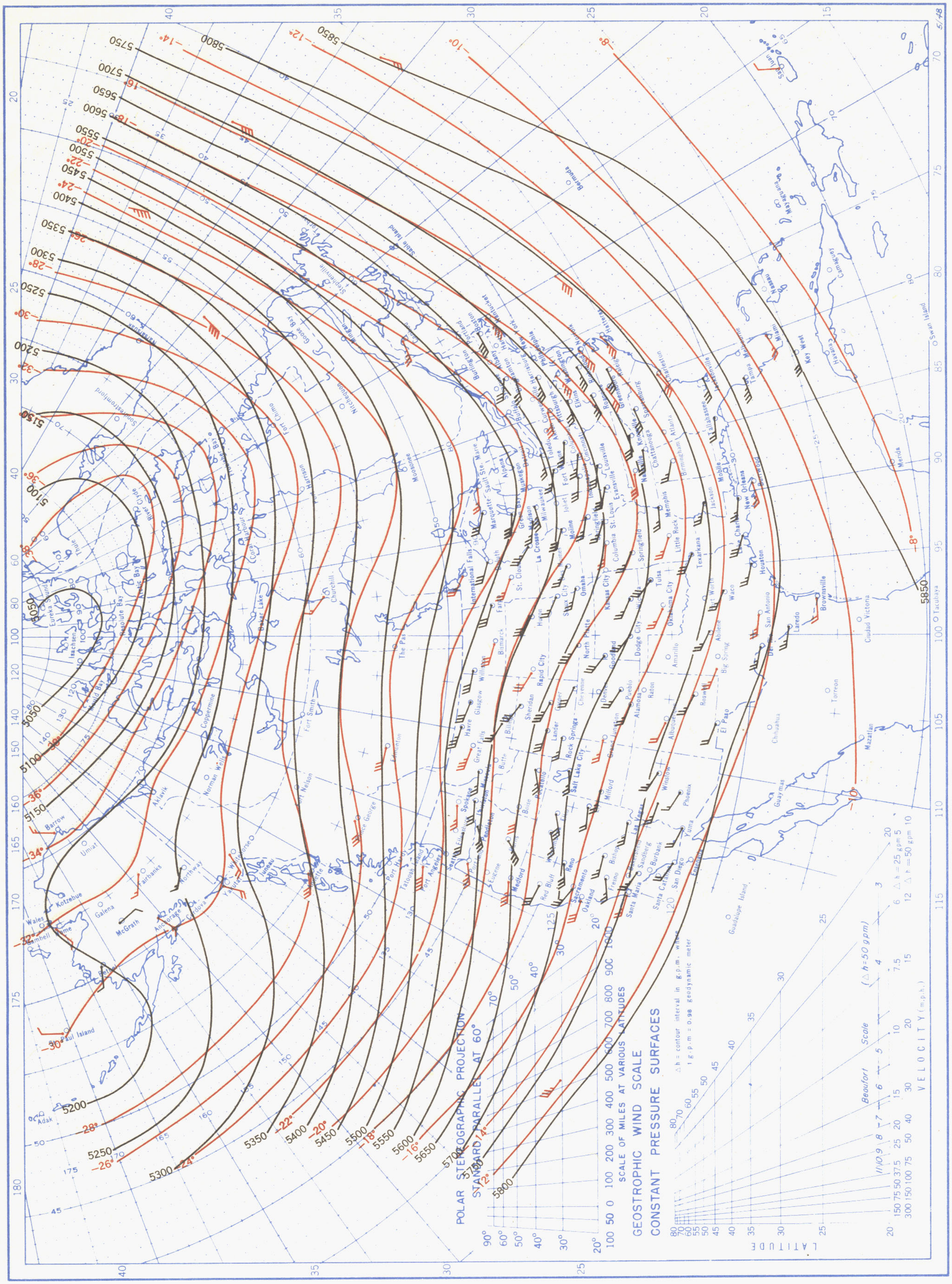
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), November 1953.



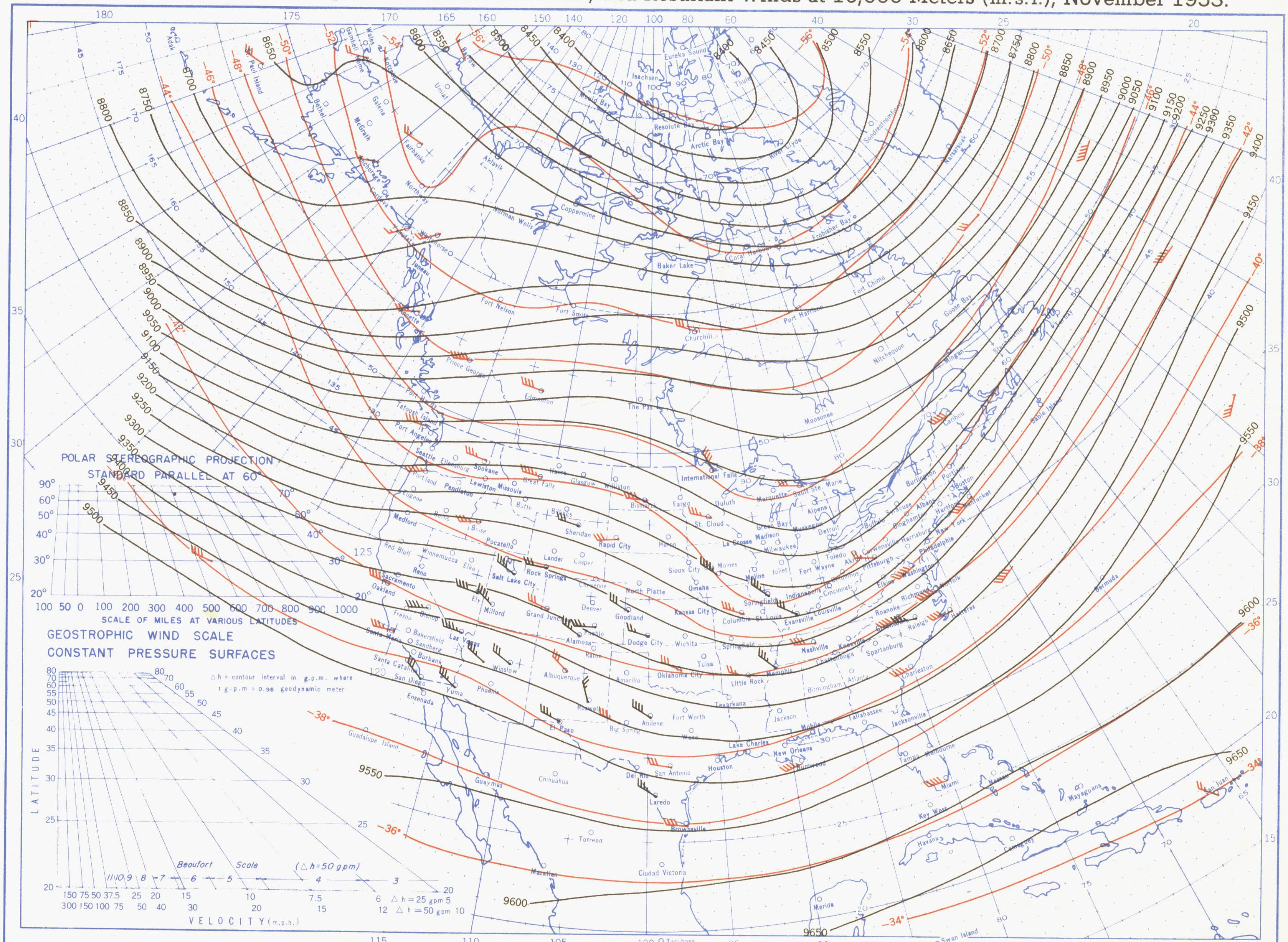
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), November 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), November 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.